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QUALITY ASSURANCE PROJECT PLAN FOR SAMPLING AND ANALYSIS - GROUNDWATER AND GAC PLANT MONITORING

Prepared by

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3. PROJECT DESCRIPTION

3.1 Background

Groundwater in the city of St. Louis Park, Minnesota has been contaminated by activities at a coal-tar distillation and wood preserving plant operated from 1917 to 1972. Numerous previous studies have identified polynuclear aromatic hydrocarbons (PAH) present in various aquifers beneath St. Louis Park and adjacent communities.

The United States Environmental Protection Agency (EPA), the Minnesota Pollution Control Authority (MPCA), the Minnesota Department of Health (MDH), the City of St. Louis park (SLP), and Reilly Tar & Chemical Corporation (Reilly) have agreed to acceptable water quality criteria for PAH. These criteria, as incorporated into the Consent Decree - Remedial Action Plan (RAP), include the following concentration levels:

		Advisory Level	Drinking Water Criteria
o	Sum of benzo(a) pyrene and dibenz(a,h) anthracene	3.0 ng/1*	5.6 ng/1
o	Carcinogenic PAH	15 ng/1	28 ng/1
o	Other PAH	175 ng/1	280 ng/1

*or the lowest concentration that can be quantified, whichever is greater

In conjunction with the implementation of remedial measures to limit the spread of contaminants, a granular activated carbon (GAC) treatment system has been installed to treat water from St. Louis Park (SLP) wells 10 and 15. Further provisions of the Remedial Action Plan (RAP) call for long-term monitoring of the influent and effluent of the GAC treatment plant and the major aquifers underlying the region. The general objective of the monitoring program is to identify the distribution of PAH and/or phenolics in the ground water. The analytical data will be used to evaluate contamination by comparing the levels of PAH and/or phenolics found in the various samples with historical water quality data and with water quality criteria established in the Consent Decree-RAP. The specific objectives of the sampling and analysis program, and therefore, the intended end use of the data vary slightly for the different aquifers (Mt. Simon-Hinckley, Ironton-Galesville, Prairie du Chien-Jordan, St. Peter, and Drift- Platteville) being monitored in accordance with the Consent Decree-RAP.

3.2 Objectives and Intended Data Usage

The GAC plant monitoring is being done to assess and continuously evaluate the performance of the treatment system. Analytical results for influent and effluent samples will be compared to the drinking water criteria for PAH as established in the Consent Decree-RAP. Based on these comparisons, decisions will be made on: 1) possible modifications to the treatment system (e.g., adding another carbon column), 2) system operations (e.g., when the carbon should be replaced), and 3) cessation of the treatment system, if desired, when sufficiently low concentrations of PAH in influent samples are demonstrated.

The objective of sampling the four existing Mt. Simon-Hinckley Aquifer municipal drinking water wells, and sampling any new Mt. Simon-Hinckley Aquifer municipal drinking water wells installed within one mile of well W23, and analyzing for PAH is to assure the continued protection of these wells from PAH resulting from activities of Reilly at the site. The analytical data will be used to make comparisons between the levels of PAH found in the Mt. Simon-Hinckley Aquifer, and the drinking water criteria established in the Consent Decree-RAP.

The objective of sampling and analyzing the Ironton-Galesville Aquifer source control well (W105) is to assess the levels of PAH in the discharge from W105 when it is pumping a monthly average of 25 gallons per minute. The data will be used to compare the concentration of total PAH in the samples to a cessation criterion of 10 micrograms per liter of total PAH established in the Consent Decree-RAP. Also, if any new Ironton-Galesville Aquifer drinking water wells are installed within one mile of well W23, then those wells will be sampled and analyzed for PAH to meet the objective of assuring protection of the well from PAH resulting from the activities of Reilly at the site. The analytical data would be used to compare the levels of PAH found in potential Ironton-Galesville Aquifer drinking water wells to the drinking water criteria established in the Consent Decree-RAP.

The objectives of monitoring the many Prairie du Chien-Jordan Aquifer wells, including municipal drinking water wells, private or industrial wells, and monitoring wells are to: 1) monitor the distribution of PAH in the aquifer, thus evaluating the source and gradient control system, and 2) assure the continued protection of drinking-water wells from PAH resulting from the activities of Reilly at the site. The analytical data will be used to compare the levels of PAH in the Prairie du Chien-Jordan Aquifer to historical PAH data and to various criteria established in the Consent Decree-RAP (e.g., drinking water criteria for drinking water wells, and a cessation criterion of 10 micrograms per liter of total PAH for source control well W23). Analytical data for samples of the discharge from gradient control well SLP4 will be compared to discharge limitations in an NPDES permit which will be applied for at the conclusion of a Feasibility Study to determine the appropriate disposition of SLP4 discharge. Water level data will be used to evaluate ground-water flow patterns in the Prairie du Chien-Jordan Aquifer.

The objective of monitoring St. Peter Aquifer wells is to determine the nature and extent of PAH in the St. Peter Aquifer resulting from the activities of Reilly at the site. The analytical data will be used to compare the levels of PAH in the St. Peter Aquifer to historical PAH data and to the drinking water criteria established in the Consent Decree-RAP. Water level data will be used to evaluate ground-water flow patterns in the St. Peter Aquifer.

The objectives of monitoring the Drift-Platteville Aquifer wells are to: (1) monitor the distribution of PAH and phenolics in the aquifer, thus evaluating the source and gradient control systems, and (2) to further define the nature and extent of PAH and phenolics in the Northern Area of the Drift-Platteville Aquifer resulting from the activities of Reilly at the site. The analytical data will be used to compare levels of PAH and phenolics in the Drift-Platteville Aquifer with historical water quality data for the aquifer and with various criteria established in the Consent Decree-RAP for PAH and phenolics. Water level data will be used to evaluate ground-water flow patterns in the Drift-Platteville Aquifer.

The Site Management Plan outlines the scope of work to be performed in order to monitor the ground water in the St. Louis Park, MN area in accordance with the Consent Decree-RAP related to the Reilly Tar & Chemical Corp. N.P.L. site. Included in this plan are: (1) the identity of wells to be monitored, (2) the schedule for ground-water monitoring, and (3) a description of the procedures that will be used for sample collection, water level measurement, sample handling, sample analysis, and reporting.

The time period covered by this Plan is from the date of its acceptance and approval by the Agencies, or January 1, 1989 whichever date is later, to December 31, 1989. A subsequent Sampling Plan (RAP Section 3.3) will be submitted by October 31, 1989, covering the 1990 calendar year.

This Plan was prepared, in part, based on the knowledge and experience gained from monitoring conducted under the Initial Sampling Plan. The Initial Sampling Plan was approved in June 1988, and monitoring has been conducted in each aquifer and at the GAC plant in accordance with that Plan. Several improvements in the area of sample analysis have been incorporated into this Plan, while sample collection procedures remain unchanged. Elsewhere, this Plan has been updated to reflect the monitoring that has already taken place, changes in project personnel, and other procedural changes.

4. PROJECT ORGANIZATION AND RESPONSIBILITIES

This project is being conducted in accordance with the Consent Decree-Remedial Action Plan (RAP) for the Reilly Tar & Chemical Corporation N.P.L site in St. Louis Park, Minnesota. The parties to the Consent Decree include Reilly, the City of St. Louis Park (SLP), EPA, MPCA, and MDH. The project organization shown in Figure 4-1 indicates the involvement of the parties to the Consent Decree, as appropriate. The City shall be assisted by two consultants in the retrieval and laboratory analysis of water samples.

ENSR Consulting and Engineering (ENSR) will be responsible for the coordination of all field sample retrieval and Enseco/Rocky Mountain Analytical Laboratory (RMAL) with analytical facilities in Arvada, Colorado, will be responsible for the coordination and completion of all laboratory analyses. Responsibilities of the key positions in the organization of RMAL are described below:

- Laboratory Project Manager: The Laboratory Project Manager is ultimately responsible for all laboratories and is the primary point of contact for issues surrounding this Quality Assurance Project Plan (QAPP), resolving technical problems, modifications to Standard Operating Procedures (SOP's) etc.

- Laboratory Project Coordinator: The Laboratory Project Coordinator is responsible for the cordination of routine day to day project activities including project initiative, status tracking, data review and requests, inquiries and general communication related to the project.

- Operations Manager: The Operations Manager is responsible for oversight of preparation and analysis of PAH samples to ensure that project objectives, requirements and Quality Assurance/Quality Control (QA/QC) criteria are met.

- Laboratory Supervisor: The Laboratory Supervisor shall be responsible for daily supervision of technicians and analysts for PAH and total phenolics analyses.

- Preparation Supervisor: The Preparation Supervisor is responsible for oversight of sample extraction and preparation for analysis.

- Analyst: The Analyst is responsible for the analysis of water samples for the requested parameters utilizing the methods prescribed by this Plan.

- Technician: The Technician is responsible for sample extraction. This requires practical experience and knowledge in the techniques of liquid - liquid solvent extraction, Kuderna - Danish evaporation, and the quantitative preparation of sample extracts for analysis.

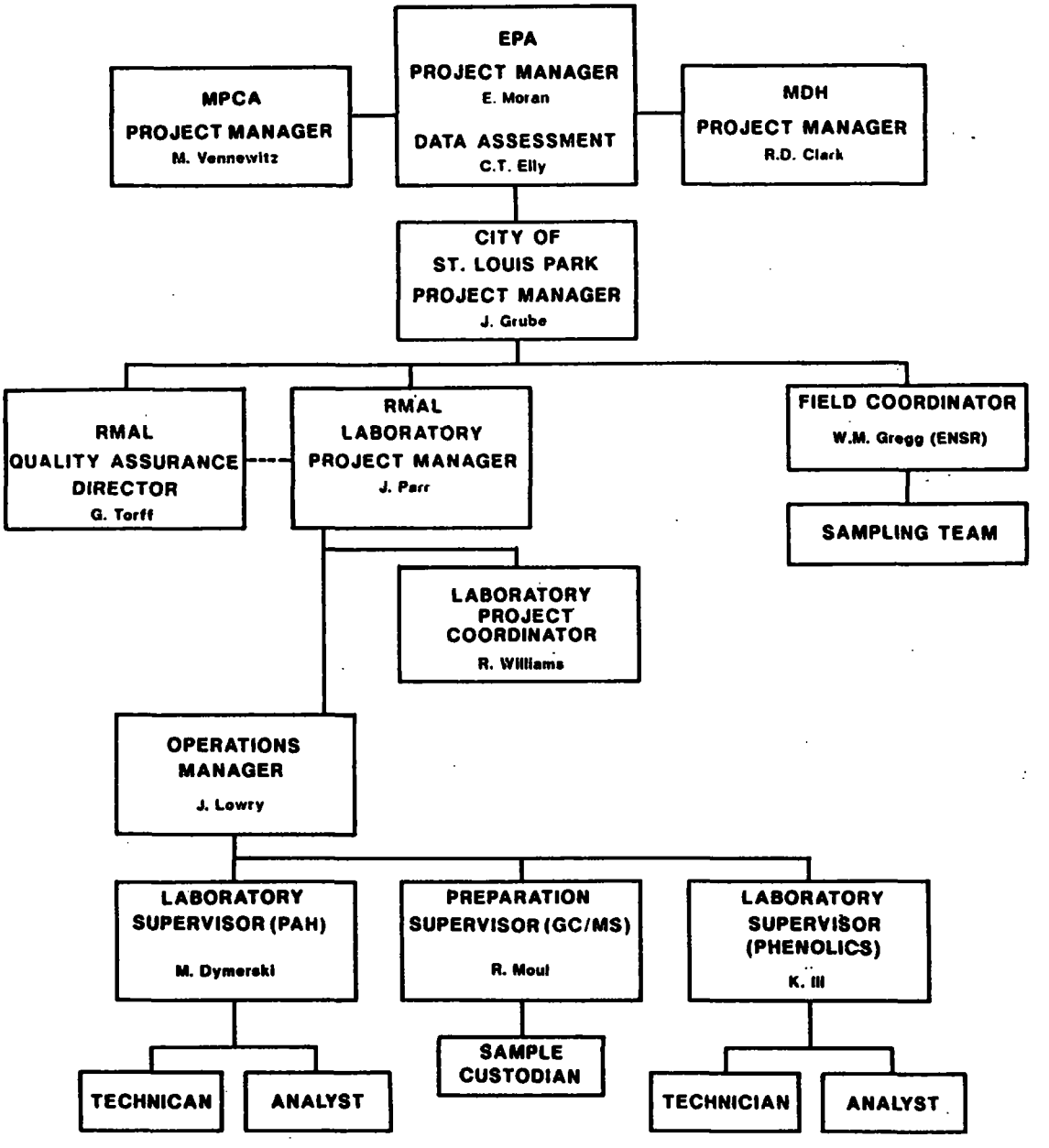


Figure 4-1 Project Organizational Chart

- Quality Assurance Director: The Quality Assurance Director is responsible for overall quality control oversight. The Quality Assurance Director supervises an independent QA/QC department and reports directly to the Division Director and Corporate Vice President for Quality Assurance.

- Sampling Team: The Sampling Team shall consist of employees of the City of St. Louis Park and ENSR. The team shall be responsible for sample collection; conducting field measurements (i.e. water level); and maintaining proper decontamination procedures stated in the QAPP.

- Data Assessment: The evaluation of data, as it is compiled and organized in accordance with the requirements of the QAPP, is the responsibility of the Operations Manager. Additional review, evaluation, and assessment of the data is performed by the Laboratory Manager, thereby providing additional assurance that the requirements of the QAPP are met.

- The EPA Contract and Program Management Section (CPMS), Region V, shall be responsible for the review of up to 10 percent of the reports and data packages generated in accordance with Section 10.3. of this QAPP.

5. QUALITY ASSURANCE OBJECTIVES

The principal objectives of this Plan pertain to the collection of data that are sufficient to monitor the effectiveness of the GAC treatment system and to detect changes in groundwater quality. Therefore, the quality of the data gathered in this project can be defined in terms of the following elements:

- Completeness - a sufficient number of successful (valid) measurements to characterize the concentrations of PAH in the influent and effluent of the treatment system and in the aquifers of interest over a period of time.

- Representativeness - the extent to which reported analytical results truly depict the PAH concentrations in the sampled environment. Representativeness is optimized through proper selection of sampling sites, times and procedures, through proper sample preservation, and through prompt extraction and analysis.

- Accuracy and Precision - Accurate and precise data will be achieved through the use of sampling and analytical procedures that minimize biases, through the use of standard procedures, through the meticulous calibration of analytical equipment and by implementing corrective action whenever measured accuracy and precision exceed pre-established limits. Accuracy and precision will be measured by the analysis of method spikes and duplicate samples.

- Sensitivity - determination of instrument sensitivity is accomplished by calibration using multiple concentrations of the analytes of interest. Once instrument sensitivity is demonstrated, analysis of replicate spiked samples of deionized reagent water at a concentration of 1-5 times the instrument sensitivity, is used to determine method sensitivity (i.e. method detection limit)

- Comparability - the extent to which comparisons among separate measurements will yield valid conclusions. Comparability among measurements in the SLP monitoring program will be achieved through the use of rigorous standard sampling and analytical procedures.

- Traceability - the extent to which results can be substantiated by hard-copy documentation. Traceability documentation exists in two forms: that which links final numerical results to authoritative measurement standards, and that which explicitly describes the history of each sample from collection to analysis.

The fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment and correction, as follows:

1) Prevention of defects in the quality through planning and design, documented instructions and procedures, and careful selection and training of skilled, qualified personnel;

2) Quality assessment through a program of regular audits and inspections to supplement continual informal review;

3) Permanent correction of conditions adverse to quality through a closed-loop corrective action system.

The St. Louis Park sampling program Quality Assurance Project Plan has been prepared in direct response to these goals. This Plan describes the quality assurance program to be implemented and the quality control procedures to be followed by RMAL during the course of laboratory analyses in support of the various site investigation studies for the St. Louis Park site. The QA objectives will include field blanks, method blanks, field duplicates, surrogate spikes, and matrix spikes. Precision, accuracy and completeness criteria are established for each parameter of interest. The specific criteria for each analysis and parameter are set forth in detail in the following sections:

Objective	Frequency	Sections Discussing Criteria
Field Duplicates	10%	6.8, 11.1.4
Field Blanks	10%	6.5.2, 15.2.3
Method Blanks	5%	11.1.1, 15.1.3
Surrogate Spikes	100% of GC/MS analyses	11.1.2, 15.1.1
Matrix Spikes	5%	11.1.3, 15.1.2

6. SAMPLING PROCEDURES

Samples will be collected by ERT and SLP personnel. The overall sampling program is summarized in Tables 6-1 and 6-2, and Figures 6-1 through 6-5. This section discusses general QAPP provisions relevant to sample collection, containerization, packaging and shipping activities.

6.1 Training

All ENSR and SLP personnel working on the project will be properly trained, qualified individuals. Prior to commencement of work, personnel will be given instruction specific to this project, covering the following areas:

- Organization and lines of communication and authority
- Overview of the Site Management Plan and QAPP,
- Documentation requirements,
- Decontamination requirements,
- Health and Safety considerations.

Training of field personnel will be provided by the Field Coordinator or a qualified designee.

The analysts performing chemical analyses of samples will be trained in and will have exhibited proficiency in the analytical methods to be employed.

6.2 Document Control

Document Control for the Sampling Plan serves a two-fold purpose. It is a formal system of activities that ensures that:

1) All participants in the project are promptly informed of revisions of the QAPP; and

2) All documents generated during the course of the program are accounted for during, and at the end of the project.

This Plan and all Standard Operating Procedure documents have the following information on each page:

- Document Number
- Page Number
- Total number of pages in document
- Revision number
- Revision date

TABLE 6-1
SAMPLING PLAN GAC PLANT
MONITORING SCHEDULE[a]

RAP Section	Sampling Points	Start of Monitoring	Sampling Frequency	Analyses[b]
4.3.1(C)	Treated water(TRTD)	Date of plan approval	Quarterly	PAH(ppt)[c]
4.3.3(C)	Feed water(FEED)	Date of plan approval	Annually	PAH(ppt)
4.3.4	Treated water	Date of plan approval	Annually	Extended PAH(ppt)
4.3.4	Treated or Feed water	Date of plan approval	Annually	Acid fraction compounds in EPA Test Method 625.

(a) This schedule does not include certain contingencies (eg. exceedance monitoring) and, therefore, represents the minimum program that is likely to occur between the date this Plan is approved and December 31, 1989. Sections 4 and 12 of the RAP outline the additional sampling that will be conducted if PAH criteria are exceeded. The first samples will be collected during the period indicated by the monitoring frequency following the date of the start of monitoring. The location of the GAC plant is shown in Figure 6-1.

(b) List of parameters and methods for analysis of PAH, extended PAH, and acid fraction compounds in EPA Test Method 625 are provided in the QAPP. Field blanks will be collected and analyzed at a frequency of one per day or one per 10 samples, whichever is more frequent. Treated water will be duplicated at a rate of 100%. Feed water duplicate samples will be collected and analyzed at a frequency of one per 10 samples.

(c) ppt = parts per trillion. This signifies analysis using selected ion monitoring gas chromatography mass spectrometry.

TABLE 6-2
SAMPLING PLAN GROUND WATER
MONITORING SCHEDULE [a]

Source of Water	RAP Section	Sampling[j] Points	Start of Monitoring	Sampling Frequency	Analyses[b]	Duplicate Samples
Mt. Simon-Hinckley Aquifer	5.1	SLP11,SLP12, SLP13,SLP17	Date of plan approval	Annually	PAH(ppt)[c]	SLP17
	5.3.2	New municipal wells within one mile of well W23	At the time of installation	Annually	PAH(ppt)	
Ironton-Galesville Aquifer	6.1.4	W105 W38[e]	Date of plan approval	Semi-annually	PAH(ppb)[d]	W105
	6.2.1	New municipal wells within one mile of well W23	At the time of installation	Annually	PAH(ppt)	
Prairie du Chien-Jordan Aquifer	7.3(A)	SLP4	Start of pumping	Quarterly	PAH(ppt) phenolics	SLP4
	7.3(B)	W23	Date of plan approval	Semi-annually	PAH(ppb)	
	7.3(C)	SLP6,SLP7 or SLP9,W48	Date of plan approval	Quarterly	PAH(ppt)	SLP6
	7.3(D)[k]	AHM or MGC[g] E2,E13,H3, SLP10 or SLP15, SLP14,SLP16,W402[h] W403,W119	Date of plan approval	Semi-annually	PAH(ppt)	W119
	7.3(E)[k]	SLP5,H6,E3, E15,MTK6, W29,W40, W70,W401	Date of plan approval	Annually	PAH(ppt)	W70

TABLE 6-2 (Continued)

Source of Water	RAP Section	Sampling[j] Points	Start of Monitoring	Sampling Frequency	Analyses[b]	Duplicate Samples
	7.3(F)	W112,W32, SLP8,SLP10, E4,E7	Date of plan approval	Quarterly	No Chemical analyses[f]	
St. Peter Aquifer	8.1.3	SLP3 plus six additional monitoring wells[l]	Date of plan approval	Annually	PAH(ppt)	SLP3 1 Monitor Well
Drift-Platteville Aquifer	9.1.3 and 9.2.3	W420,W421, W422	Date of plan approval	Quarterly	PAH(ppb) and total phenols	W422
	9.6	Drift:W2,W6 W10,W11,W12, W116,W117, W128,W135,W136 W423,W425,W427, P109,P112, Platteville: W1,W18,W19,W20, W27,W101, W120,W121, W124,W130, W131, W143,W424,W426, W428	Date of plan approval	Annually[i]	PAH(ppb) and total phenols	W11,W423,W428

(a) This schedule does not include certain contingencies (e.g. exceedance monitoring) and, therefore, represents the minimum program that is likely to occur between the date this Plan is approved and December 31, 1989. Section 12 of the RAP outlines the additional sampling that will be conducted if the drinking water criteria are exceeded in samples from water supply wells. The first samples will be collected during the period indicated by the monitoring frequency following the date of the start of monitoring. Field blanks will be collected at a frequency of one per day, and one duplicate sample will be collected for every 10 samples.

TABLE 6-2 (Continued)

(b) Lists of parameters and descriptions of the methods for analysis of PAH, phenolics, and expanded analyses are provided in the QAPP. Water levels will be measured each time samples are collected for analysis, except for those wells which prove to be inaccessible for such measurements.

(c) ppt = parts per trillion. This signifies analysis using selected ion monitoring gas chromatography mass spectrometry.

(d) ppb = parts per billion. This signifies analysis by EPA Method 625. If analytical results for individual wells are below 20 micrograms per liter (20 ppb) using this method, then the part per trillion method will be used on subsequent monitoring rounds.

(e) Water levels in W38 will be measured each time W105 is sampled.

(f) Water levels only (no monitoring) will be measured at these wells, except for those wells which prove to be inaccessible for such measurements.

(g) AHM = American Hardware Mutual, MGC = Minikahda Golf Course.

(h) Well W402 may or may not be available for sampling at the same time as the other wells on these lists. It will be sampled in conjunction with the monitoring performed in accordance with the schedule shown, once it has been constructed.

(i) If any of the wells listed here become damaged, destroyed, or otherwise unsuitable for sampling, alternate wells will be selected by the Project Leaders for monitoring.

(j) Sampling points are located on the maps shown in Figures 1 through 5. Letter prefixes to well codes are defined as follows:

W - 4-inch monitoring well
P - monitoring piezometer
SLP - St. Louis Park supply well
E - Edina supply well
H - Hopkins supply well
MTK - Minnetonka supply well

(k) Water level measurements will be made quarterly at these wells, except for those wells which prove to be inaccessible for such measurements.

(l) The six St. Peter Aquifer monitoring wells that will be monitored according to RAP Section 8.1.3 will be selected by the Project Leaders based on the results of the first and second monitoring rounds of 1988.

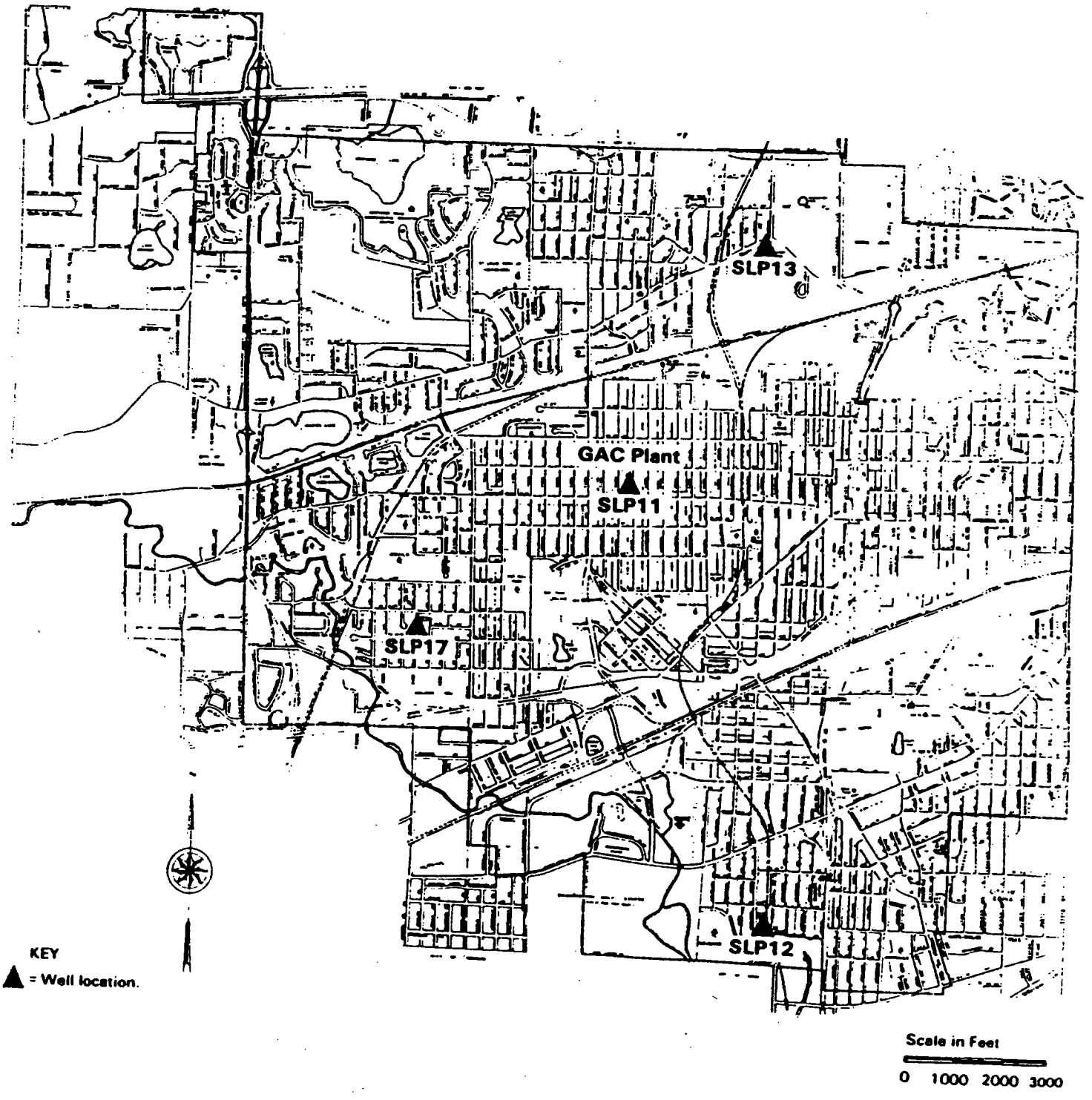


Figure 6-1 Location of Mt. Simon-Hinkley Monitoring Wells and St. Louis Park GAC Water-Treatment Plant

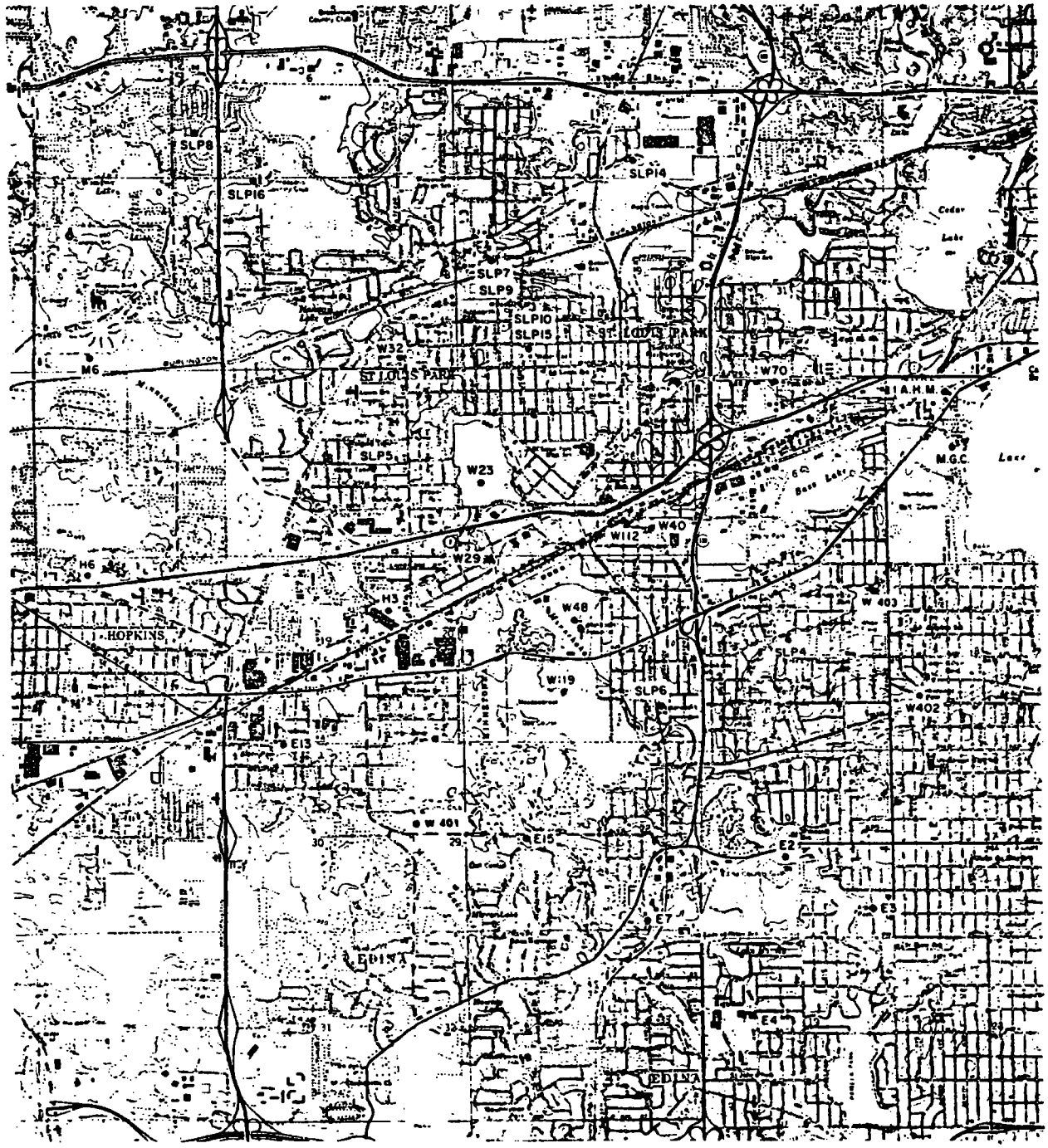


Figure 6-2 Location of Prairie du Chien-Jordan Aquifer Wells

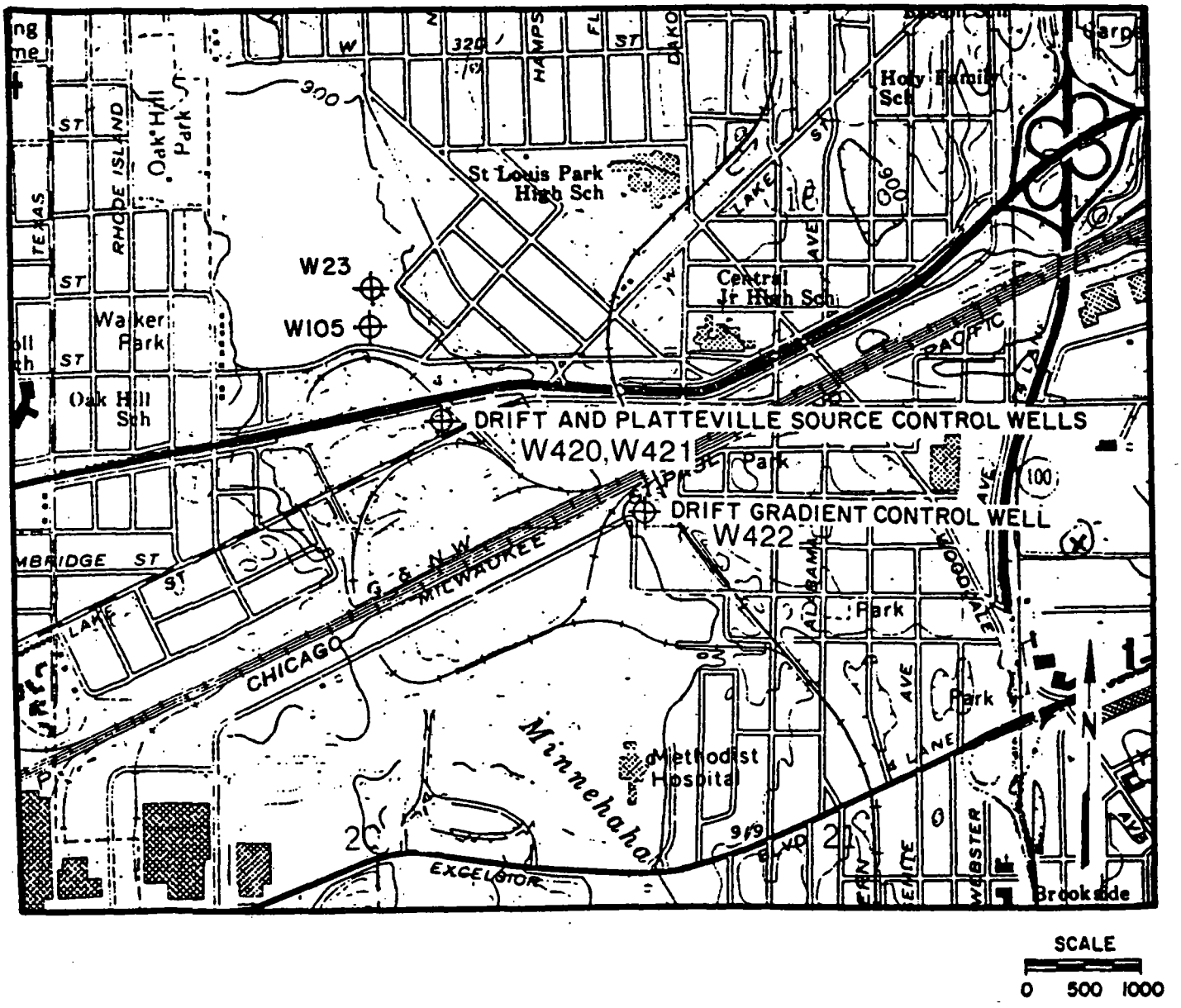
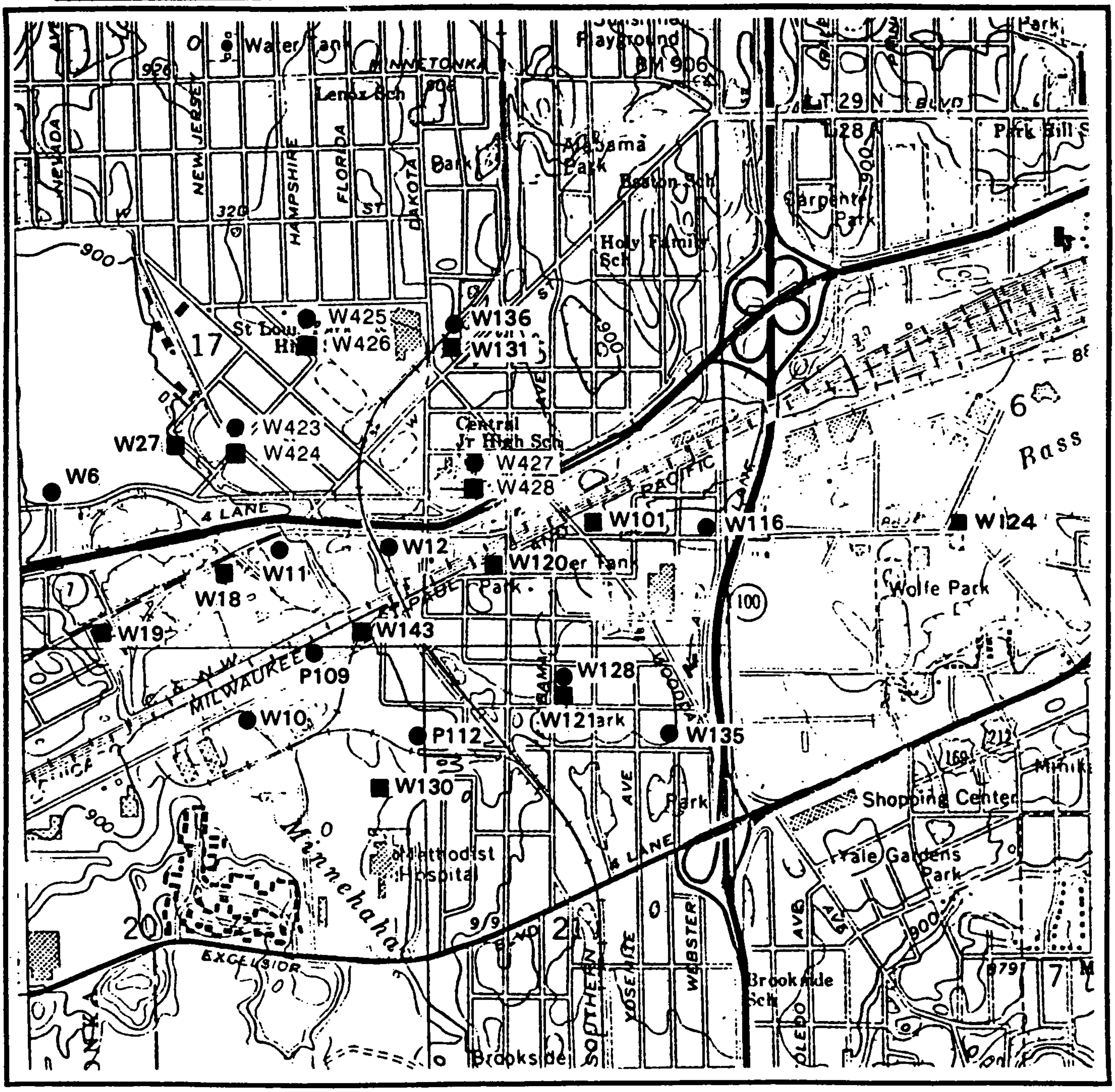


Figure 6-3 Location of Source and Gradient Control Wells



SCALE

0 500 1000 2000

FEET

N

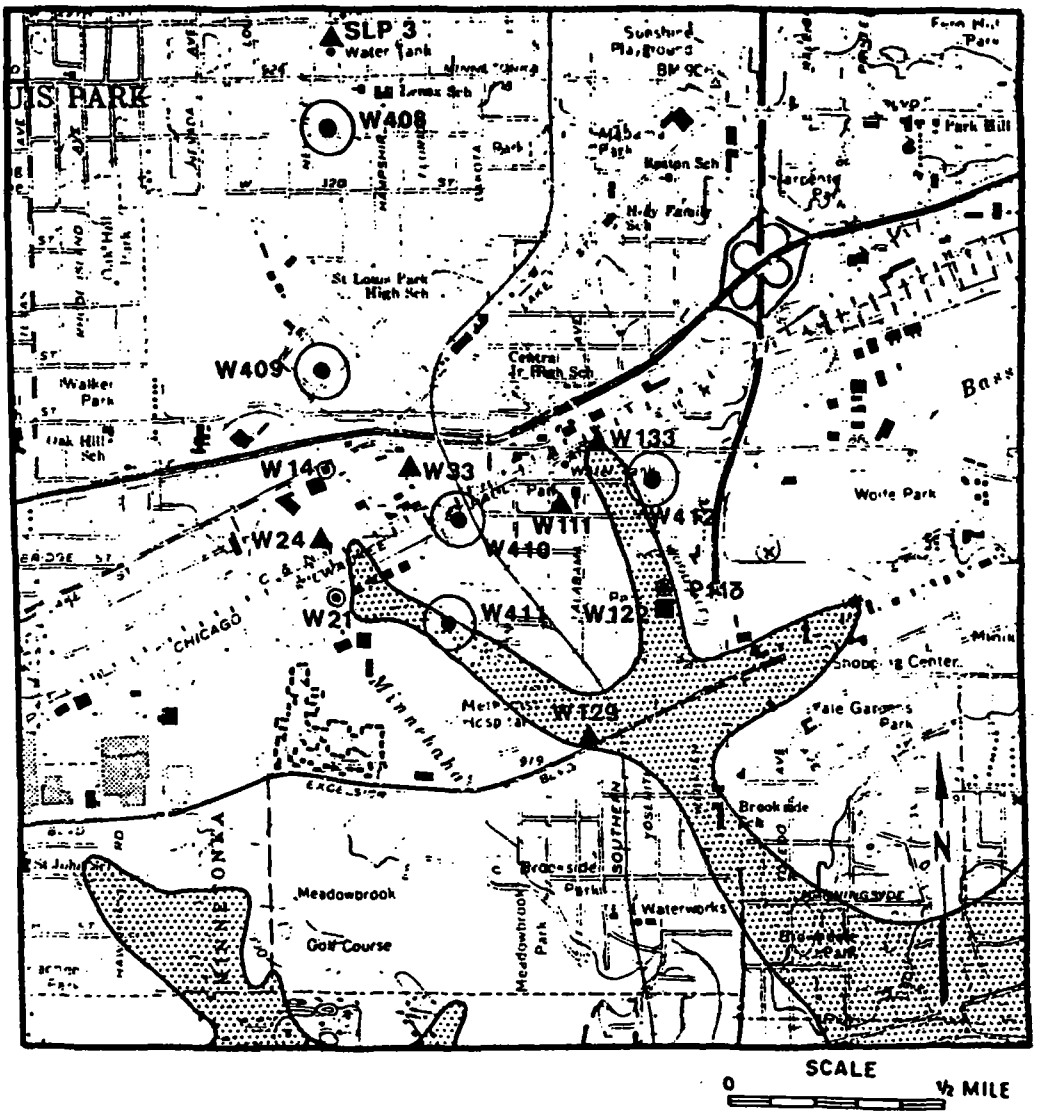
EXPLANATION

● DRIFT WELLS

■ PLATTEVILLE WELLS

Figure 6-4 Location of Drift-Platteville Monitoring Wells

Reference: MGS, Miscellaneous Map Series,
M-57, Plate 1 of 2, Bedrock Geology,
by Bruce A. Bloomgren, 1985



EXPLANATION

▲W33 LOCATION AND PROJECT WELL NUMBER

▲ OBSERVATION WELL COMPLETED IN ST. PETER AQUIFER

■ OBSERVATION WELL COMPLETED IN BASAL ST. PETER CONFINING BED

● ST. PETER MONITORING WELLS CONSTRUCTED IN 1987

◉ WELL IN WHICH WATER LEVELS WERE MONITORED WITH A DIGITAL RECORDER DURING PART OF 1978-81

BEDROCK VALLEY/CONTACT WHERE UNCONSOLIDATED DRIFT DEPOSITS OVERLIE ST. PETER SANDSTONE

Figure 6-5 St. Peter Aquifer Well Locations and Bedrock Valley

When any of these documents are revised, the affected pages are reissued to all personnel listed as document holders with updated revision numbers and dates. Issuance of revisions is accompanied by explicit instructions as to which documents or portions of documents have become obsolete.

Control of, and accounting for documents generated during the course of the project is achieved by assigning the responsibility for document issuance and archiving. Table 6-3 lists the key documentation media for the project and corresponding responsible parties for issuance, execution and archiving.

6.3 Sample Control Procedures and Chain of Custody

In addition to proper sample collection, preservation, storage and handling, appropriate sample identification procedures and chain of custody are necessary to help insure the validity of the data.

6.3.1 Sample Identification

Sample labels shall be completed for each sample, using waterproof ink, unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample tag because a ballpoint pen would not function in freezing weather. The information recorded on the sample label includes:

Sample Number - Unique coded sample identification number as described below.

Time - A four-digit number indicating the military time of collection.

Sampler - Signature of person collecting the sample.

Remarks - Any pertinent observations or further sample description. The sample number includes three parts (source code, sampling point code, and date code) in the following sequence:

XXX-YYYYY-ZZZZZZ

TABLE 6-3
DOCUMENT CONTROL

Item	Issued By	Issued To	Archived By
Field Notebooks	Field Coordinator	Sampling Team	Field Coordinator
Field Equipment Calibration Forms	Field Coordinator	Sampling Team	Field Coordinator
Sample Logs	Field Coordinator	Sampling Team	Field Coordinator
Chain-of-Custody Forms	Lab Sample Custodian	Field Coordinator	Lab Sample Custodian
Sample Labels	Field Coordinator	Sampling Team	Lab Sample Custodian

XXX = Source Code

GAC Plant	= GAC
Mt. Simon-Hinckley Aquifer	= MSH
Ironton-Galesville Aquifer	= IGV
Prairie du Chien Jordan Aquifer	= PCJ
St. Peter Aquifer	= STP
Drift-Platteville Aquifer	= DPV

YYYYY = Sampling Point Code
Well identification as abbreviated in Tables 6-1 and 6-2

ZZZZ = Date Code
Month, day, year

Those samples which will be taken in accordance with this Plan for quality control purposes will be identified by appending to the sampling point codes the following:

Field blank = FB
Field duplicate = D
Matrix spike = MS
Matrix spike duplicate = MSD

As an example, a field blank sample taken for the Mt. Simon-Hinckley Aquifer, sampling point SLP11 on 1 January 1988 would be identified as follows:

MSH-SLP11FB-010188

During the sampling event, one sample will be taken per sampling point unless it is duplicated. Duplicate samples will be collected as specified in Tables 6-1 and 6-2. Those samples collected for matrix spike analysis will be selected at the time of sampling and labelled in the field.

Ater collection, identification, and preservation, the sample will be maintained under chain-of-custody procedures discussed below.

6.3.2 Chain-of-Custody Procedures

To maintain and document sample possession, chain-of-custody procedures will be followed. A sample is under custody if:

- It is in someone's possession, or
- It is in someone's view, after being in their possession, or
- It was in someone's possession and they locked it up to prevent tampering, or
- It is in a designated secure area.

Samples are accompanied by a Chain-of-Custody Record (Figure 6-6). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst at the laboratory.

Minimum information recorded on the chain-of-custody record in addition to the signatures and dates of all custodians will include:

- Sampling site indentification
- Sampling date and time
- Identification of sample collector
- Sample identification
- Sample description (type and quantity)
- Analyses to be performed.

Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each shipment. Shipping containers will be sealed for shipment to the laboratory. The method of shipment, courier name(s) and other pertinent information are entered in the "Remarks" box. Then tear off the last copy of the form and place the original and remaining copies in the container. After the container is closed, place the custody seals on the container.

Whenever samples are split with another laboratory, it is noted in the "Remarks" section. The note indicates with whom the samples are being split and is signed by both the sampler and recipient. If either party refuses a split sample, this will be noted and signed by both parties. The person relinquishing the samples to the facility or agency should request the signature of a representative of the appropriate party, acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Remarks" space. When appropriate, as in the case where the representative is unavailable, the custody record should contain a statement that the samples were delivered to the designated location at the designated time.

Enseco - Rocky Mountain Analytical

4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Facsimile: 303/431-7171

Attn: _____

CHAIN OF CUSTODY

No. 5001

Enseco Client _____

Project _____

Sampling Co. _____

Sampling Site _____

Team Leader _____

SAMPLE SAFE™ CONDITIONS

1. Packed by: _____ Seal # _____
2. Seal Intact Upon Receipt by Sampling Co.: Yes No
3. Condition of Contents: _____
4. Sealed for Shipping by: _____
5. Initial Contents Temp.: _____ °C Seal # _____
6. *Sampling Status:* Done *Continuing Until* _____
7. Seal Intact Upon Receipt by Laboratory: Yes No
8. Contents Temperature Upon Receipt by Lab: _____ °C
9. Condition of Contents: _____

Date	Time	Sample ID/Description	Sample Type	No. Containers	Analysis Parameters	Remarks

CUSTODY TRANSFERS PRIOR TO SHIPPING

	Relinquished by: (signed)	Received by: (signed)	Date	Time
1				
2				
3				

SHIPPING DETAILS

Delivered to Shipper by: _____

Method of Shipment: _____ Airbill # _____

Received for Lab: _____ Signed: _____ Date/Time _____

Enseco Project No. _____

White and Pink Copies to Lab *Yellow to Sampler* SS-001

Figure 6-6 Sample Chain of Custody Record

6.3.3 Field Forms

In addition to sample labels and chain-of-custody forms, a bound field notebook will be maintained by the sample team leader to provide a daily record of significant events. All entries will be signed and dated. All members of the of the sampling team will use this notebook. The notebook will be kept as a permanent record.

6.4 Sampling Procedures - GAC Plant

Chain-of-custody forms will be completed and all samples shipped to RMAL's laboratory by overnight delivery on the same day they are collected.

Sampling points will be flushed for at least five minutes before collecting a sample. Each PAH sample will be collected in six one-liter amber glass bottles, which should be filled and capped in succession. PAH sample bottles will not be rinsed before being filled. The lids of all sample bottles will be taped using plastic adhesive tape after they are capped.

The GAC treated water samples will have to be collected from two sample taps -- one for each column (see Figure 6-7). This will be done by filling three one-liter bottles from the first column sample tap and then three more bottles from the second (six from each for duplicate samples). No notations distinguishing the two taps will be made on the labels. Only four PAH bottles will be extracted and the extracts composited for analysis.

Field blank samples will be prepared by transferring contaminant-free deionized water provided by RMAL into sample bottles in a fashion as closely similar to actual sample collection as possible. Field blank sample bottles will be filled, capped and taped in succession with individual bottles open to the atmosphere for an equal time as for actual process samples. Field blanks will be prepared in the area in which GAC treated water samples are collected.

Duplicate samples will be obtained by filling twelve 1-liter bottles at the sampling point by the procedure described above, splitting these into two groups of six bottles, and assigning a different sample number to each of the resulting six-bottle samples. All samples will be packed, cooled to a temperature less than $4^{o}C$, and shipped on the day they are collected.

The sampling team must recognize that great care is required to collect samples for part-per-trillion-level PAH analysis that are free from outside contamination. PAH compounds are present in cigarette smoke, engine exhaust and many petroleum derived oils, among other sources. There will be no smoking anywhere in the GAC treatment building on a day on which PAH-samples are to be collected until the samples have been collected, sealed and packaged for shipment. Similarly, no vehicles will enter the GAC treatment building and the large access door will stay closed on sampling days. Disposable gloves will be worn when collecting, handling and packaging samples. Sample bottles will remain in closed shipping coolers until they are needed, and will be packaged and sealed for shipment as soon as possible after sampling.

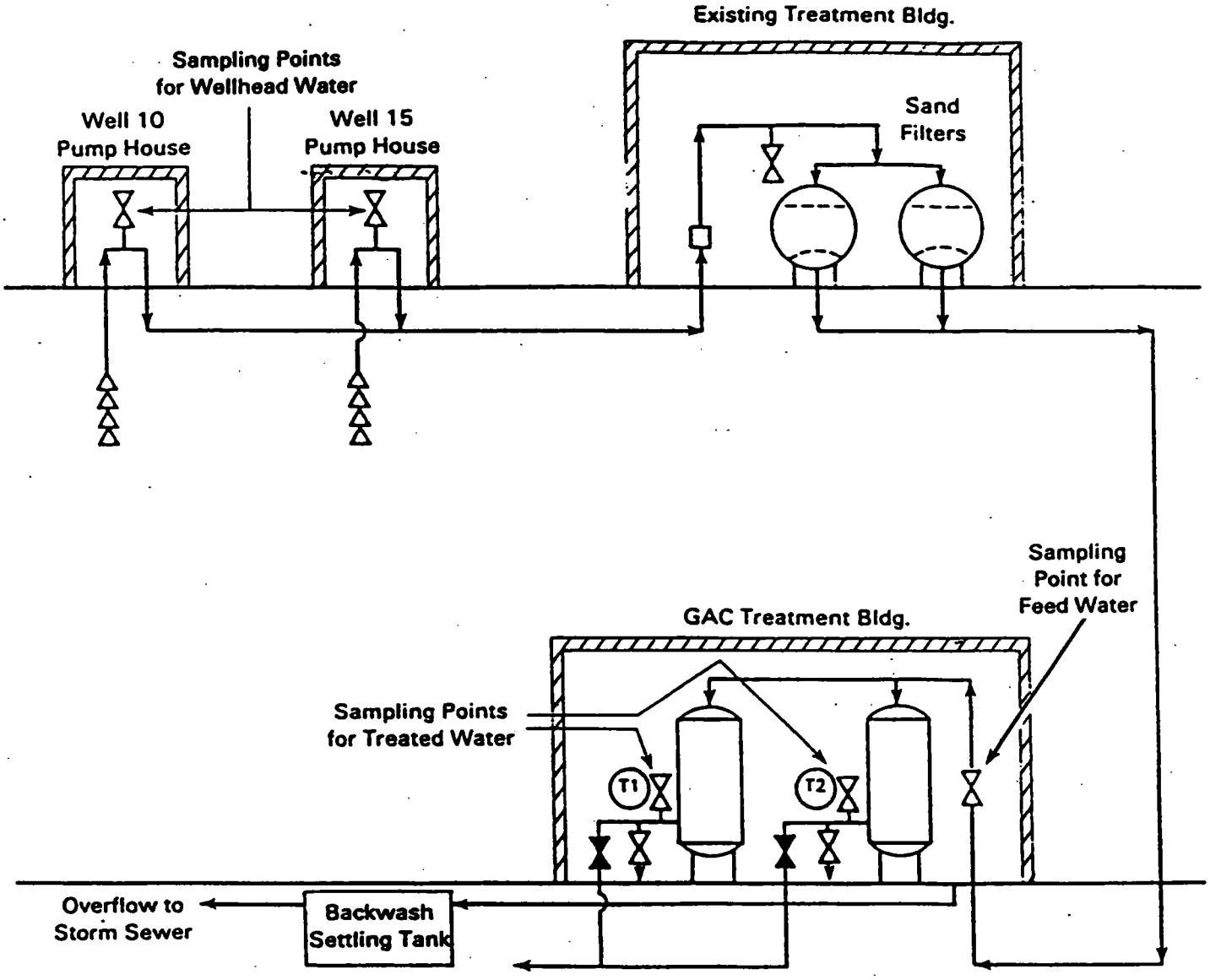


Figure 6-7 Sampling Locations

6.5 Ground-water Sampling and Water Level Measurements

Ground water samples will be collected and water level measured in accordance with the procedures outlined in this Plan. The wells involved in the monitoring program include municipal and commercial wells, piezometers and groundwater monitoring wells (see Table 6-2). Sampling procedures to accommodate the dimensions and configuration of each type of well are described below. Further details on well dimensions, water level measurements and sample acquisition strategies are given in the Site Management Plan.

The importance of proper sampling of wells cannot be over-emphasized. Even though the well being sampled may be correctly located and constructed, special precautions must be taken to ensure that the sample taken from that well is representative of the ground water at that location and that the sample is neither altered nor contaminated by the sampling and handling procedure. Sample collection will always proceed from the less contaminated sampling points to the monitoring wells containing progressively higher concentrations of PAH or phenolics.

6.5.1 Decontamination

The field decontamination procedure to be used on sampling equipment which comes into contact with groundwater samples is as follows:

- disassemble equipment, if applicable,
- high pressure, hot water steam clean, using potable water.

The laboratory decontamination procedure to be used on sampling equipment which comes into contact with groundwater samples is as follows:

- disassemble equipment
- rinse with acetone
- scrub with hot soapy water
- rinse three times with hot deionized water
- set on aluminum foil, dull side up, air dry
- bake for one hour at 200^{0} C
- wrap with aluminum foil, dull side in

6.5.2 Field Blanks

Field blank samples will be prepared by transferring contaminant-free deionized water, provided by RMAL, into sample bottles in a fashion as closely similar to actual sample collection as possible. This will involve collecting samples through any non-dedicated sample equipment that is decontaminated between samples. Field blank sample bottles will be filled, capped and taped in succession with individual bottles open to the atmosphere for an equal time as for actual process samples. Field blanks will be prepared in the area where samples are being collected at a rate of one per day or where more than ten samples are collected in a day at a rate of one field blank per ten samples.

6.5.3 Sample Containers (See Table 6-4)

For PAH and Phenolics, 1 liter amber glass bottles will be used. Caps will be fitted with pre-cleaned Teflon liners. Six bottles are required for each PAH sample collected. One bottle is required for phenolics.

Bottles will be prepared as follows:

1. Wash bottles with hot detergent water.

2. Rinse thoroughly with tap water followed by three or more rinses with organic-free water.

3. Rinse with Burdick & Jackson quality redistilled acetone, followed by equivalent quality methylene chloride.

4. Allow to air dry in a contaminant free area.

5. Caps and liners must be washed and rinsed also.

   Bottles should be stored and shipped with the Teflon-lined caps securely fastened.

6.5.4 Sample Collection - Monitoring Wells and Piezometers

Because unanticipated or changed conditions may cause difficulty in the purging and sampling of the monitoring wells and piezometers, flexibility in the approach to sample retrieval is necessary. This Plan proposes that the sampling team be given latitude in the selection of purge/sample equipment and procedures necessary to complete the monitoring task.

Table 6-2 specifies that Prairie du Chien-Jordan Aquifer monitor well W70 be monitored, and that St. Peter Aquifer monitor wells W24 and W33 may be monitored. Each well is equipped with a dedicated submersible pump and it will be the responsibility of the sampling team to determine if the pump is operable. In the event the dedicated pump within any individual well is operable, well purging and sample retrieval tasks will be completed with the aid of the pump in conformance with parameter monitoring established herein. In the event the dedicated pump within any individual well is inoperable, the pump will be removed and purging/sampling procedures will be as established below.

Monitoring wells and piezometers not equipped with dedicated submersible pumps will be purged using a nondedicated submersible pump, suction pump or bailer. During the purging of each well, temperature, pH and specific conductance of the purge water will be monitored using a Hydrolab water quality monitor (or equivalent). Readings will be taken once per well volume. Stabilization of these readings will indicate that purging is complete and sampling may

TABLE 6-4
SAMPLE CONTAINERS, PRESERVATION PROCEDURES, AND
MAXIMUM HOLDING TIMES

Parameter	Containers	Preservation[1]	Maximum Holding Time[2]
Water:			
PAH (PPT)	Four 1-liter amber glass bottles, Teflon-lined caps	cool, to 4° C; protect from light	7 days (until extraction), 40 days after extraction
PAH (PPB)	Two 1-liter amber glass bottles, Teflon-lined caps	cool, to 4° C; protect from light	7 days (until extraction), 40 days after extraction
Phenolics	One 1-liter amber glass bottle,	cool, to 4° C	7 days (until extraction), 40 days after extraction

Ref: Federal Register Guidelines/Vol.49, No.209/Friday, October 26, 1984/p. 43260.

1 Sample preservation will be performed immediately upon sample collection.

2 Samples will be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

6-4

commence. Upon completion of well purging, samples will be collected from each well using a stainless steel or teflon bailer and a new length of nylon or polyester rope. All nondedicated purging and sampling equipment will be decontaminated before use and between sampling points as described in Section 6.5.1.

Samples will be collected by filling each of the appropriate sample containers in rapid succession, without prerinsing the containers with sample. The bottle will be held under the sample stream without allowing the mouth of the bottle to come in contact with the bailer and filled completely, and the cap securely tightened. Bottles will be checked for air and if air is visible, the cap removed and more sample added. All sample labels will be checked for completeness, sample custody forms completed and a description of the sampling event recorded in the field notebook.

6.5.5 Sample Collection - Pumping Wells

At active pumping wells the sampling team will first determine that the wells have actually been pumping during the period preceding sampling. This information may be derived from inspecting flow recorders or from interviewing knowledgeable persons regarding the wells (water department employees, well owners, etc.). The information will be documented in the field notes of the sampling team.

Water level measurements will then be made, if practical. The normal operation of the well will not be interrupted for the purpose of measuring water levels. An electric tape will be used to measure water levels in pumping wells. Sampling will proceed by filling the required containers with water from the sampling tap as near to the well head as possible, and before any holding tanks or treatment is encountered.

If it can not be determined that a well has been pumping at some time during the 24 hour period preceding sampling, or if it is known the well was not pumping, then the well shall be purged until field measurements of temperature, pH, and specific conductance have stabilized after at least three well volumes have been removed from the well. These measurements, water levels, and the amount of water pumped will be recorded in the field notes.

6.6 Sample Preservation, Shipment and Storage

The samples will be iced or refrigerated at $4^{o}C$ from the time of collection until extraction. PAH's are known to be light sensitive; therefore, samples will be stored in amber bottles and kept away from prolonged exposure to light. All samples will be extracted within seven days of collection, and analysis completed within forty days following extraction.

Samples will be protected from breakage and shipped in coolers at a temperature of $4^{o}C$ or less. An overnight carrier will be selected to insure delivery at the laboratory within 24-36 hours after collection.

Samples received at the laboratory will be checked for leakage and a notation made regarding sample temperature at time of receipt. All samples should be stored in an organic-free refrigerator at $4^{o}C$. Storage refrigerators will be kept locked to prevent unauthorized entry and to satisfy chain-of-custody requirements.

6.7 Field Measurement Equipment

All field measurement equipment will be controlled to ensure that measurements obtained are accurate and defensible. Table 6-5 summarizes the parameters to be monitored, the instruments to be used for each measurement, procedures including calibration and frequency, and quality control criteria (also refer to Appendix A, SOP 7320, Calibration and Operation of Hydrolab Water Quality Monitor).

In addition, these measurement devices will be issued through a formal equipment tracking system and operated by trained personnel.

6.8 Duplicate Samples

Duplicate samples will be collected by alternately filling sample bottles from the source being sampled. For six liter sample collection one bottle will be filled for the sample, then one bottle for the duplicate, then a second bottle for the sample and then a second bottle for the duplicate, etc. Duplicates will be taken for each analysis type and each sample type, at a rate of one duplicate sample being collected for each ten samples, with a minimum of one duplicate for any sample batch. There are two sample types for this program: GAC Plant treated water and groundwater. For purposes of fulfilling the 10% duplicate requirement, all the sampling points shown on Table 6-2 are the same sample type.

TABLE 6-5
FIELD MEASUREMENT EQUIPMENT QUALITY CONTROL

Device	Calibration	Routine Check Method	Frequency	Control Limits
pH Meter (Hydrolab)	Standardize in three or more standard buffer solutions	Calibration check-analyze standard buffer solution	after every sample	±0.1 pH units
		Analyze duplicates	after every sample	±0.1 pH units
Conductivity Meter (Hydrolab)	Standardize using two or more KCL solutions	Calibration check-analyze standard KCL solution	1/10 Samples	±10% full scale
		Analyze duplicates	1/10 Samples	±10% full scale

7. SAMPLE CUSTODY

The St. Louis Park Groundwater Study is a cooperative effort between the City and ENSR, whose responsibilities include sample retrieval, and RMAL, whose responsibilities include sample analysis. Proper sample handling and analysis is essential to the success of the study, therefore a formal sample custody procedure has been developed to insure the integrity of all samples. Sections 6.4 and 6.5 discuss field sampling aspects and Section 6.6 outlines procedures for sample preservation, shipment, and storage. This section covers quality related activities from receipt of samples at the RMAL analytical facilities through issuance of validated analytical data and the storage of data in the final evidence file.

7.1 Security and Recordkeeping

Samples entering the RMAL analytical facilities located in Arvada, Colorado, proceed through an orderly chain-of-custody sequence specifically designed to insure continuous integrity of both the sample and documentation.

Appendix A contains Standard Operating Procedures (SOP's) which address the following aspects of facility security and sample custody

- Building Security - SOP No. LP-RMA-0001
- Sample Log-in - LP-RMA-0003
- Use of Project Assignment Record - LP-RMA-0004
- Sample Receipt and Chain of Custody - SOP No. LP-RMA-0005

7.2 Final Evidence File

The final evidence (or data) files will be maintained at RMAL for the period specified in the RAP. Evidence files will consist of all data necessary to completely reconstruct the analysis, and will consist of (at a minimum): raw data, continuing calibration checks, DFTPP tune, detection limits, chain of custody documentation, quality control data for blanks and matrix spikes and results forms. In addition, the analytical report, which contains a brief discussion of the method and a more detailed narrative of any analytical issues is included in the package. RMAL will maintain these files in a secure, limited access area under the custody of the Director of Quality Assurance. RMAL maintains all GC/MS raw data files on tapes or other magnetic media for an indefinite period. This data will be available upon request.

8. CALIBRATION PROCEDURES

Calibration is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established detection limits. For this project calibration is required for the following tests:

- Low Level PAH
- Non-Criteria PAH
- Extended PAH
- Phenolics

The specific calibration requirements for these analyte groups are summarized in the subsections below.

8.1 Low-Level (ppt) Analysis of PAH and Heterocycles

The calibration requirements are described in detail in the Standard Operating Procedure for ppt PAH analyses appended to this QAPP. The discussion below highlights the key aspects of the calibration requirements.

Prior to use of the method for low level analysis of PAH, a five-point response factor calibration curve must be established showing the linear range of the analysis.

A midpoint calibration standard is analyzed daily and the area of the primary characteristic ion is tabulated against concentration for each compound. The response factor (RF) for each compound listed in Table 8-1 is calculated.

These daily response factors for each compound must be compared to the initial calibration curve. If the daily response factors are within ±35 percent of the corresponding calibration curve value the analysis may proceed. If, for any analyte, the daily response factor is not within ±35 percent of the corresponding calibration curve value, a five-point calibration curve must be repeated for that compound prior to the analysis of samples.

The quantitation mass ion, which represents the 100% abundance ion, is selected for quantitation and for the daily response factor measurement. The second ion, or confirmation ion, is used for confirmation of the identification. The daily response factor for the quantitation mass ion is compared to the initial calibration curve. During the analysis of the daily calibration standard the percent abundance of the confirmation ion is obtained. This percent abundance is used for identification purposes for samples analyzed during that day. The percent abundance values shown in Table 8-1 are typical values.

Mass tuning will be performed using the mass calibration compound FC43. Tuning will be performed to maximize the sensitivity of the mass spectrometer for the mass range of compounds being analyzed. In the FC43 spectra, the ion abundance of masses 131 and 219 are adjusted to a ratio of 1:1. These two ions are then maximized to be approximately 50 to 70% of the ion abundance of the base mass 69. This procedure maximizes the sensitivity of the instrument in the mass region of interest for the PAH analysis.

TABLE 8-1 TARGET COMPOUNDS AND KEY IONS
FOR LOW LEVEL PAH ANALYSES

CAS NO.	COMPOUND	QUANTITATION MASS ION	CONFIRMATION ION (% ABUNDANCE)
271-89-6	2,3-Benzofuran	118	90 (52)
496-11-7	2,3-Dihydroindene	117	118 (57)
95-13-6	1H-Indene	116	115 (108)
91-20-3	Naphthalene	128	102 (7)
4565-32-6	Benzo(B)Thiophene	134	89 (8)
91-22-5	Quinoline*	129	102 (20)
120-72-9	1H-Indole	~~171~~ 117	90 (31)
91-57-6	2-Methylnaphthalene	141	115 (31)
90-12-0	1-Methylnaphthalene	141	115 (28)
92-52-4	Biphenyl	154	153 (35)
208-96-8	Acenaphthylene	152	151 (17)
83-32-9	Acenaphthene	154	153 (93)
132-64-9	Dibenzofuran	168	139 (40)
86-73-7	Fluorene	166	165 (90)
132-65-0	Dibenzothiophene	184	139 (19)
85-01-8	Phenanthrene	178	176 (19)
120-12-7	Anthracene	178	176 (19)
260-94-6	Acridine	179	178 (26)
86-74-8	Carbazole	167	166 (28)
206-44-0	Fluoranthene	202	200 (17)
129-00-0	Pyrene	202	200 (18)
56-55-3	Benzo(A)Anthracene*	228	226 (22)
218-01-9	Chrysene*	228	226 (26)
205-99-2	Benzo(B)Fluoranthene*	252	250 (22)
207-08-9	Benzo(K)Fluoranthene	252	250 (22)
192-97-2	Benzo(E)Pyrene	252	250 (35)
50-32-8	Benzo(A)Pyrene*	252	250 (26)
198-55-0	Perylene	252	250 (24)
193-39-5	Indeno (1,2,3-CD)Pyrene*	276	274 (25)
53-70-3	Dibenz(A,H)Anthracene*	278	279 (20)
191-24-2	Benzo(G,H,I)Perylene*	276	274 (25)
205-82-3	Benzo(J)Fluoranthene*	252	250 (22)

NOTE: The % abundance for the confirmation ion is a typical value. Although these ratios will vary, the relative intensities of confirmation ions must agree within plus or minus 20% between the calibration standard for any given day and the samples run on that day.

* Carcinogenic PAH as defined in Appendix A of the RAP.

The requirements above will be employed for all compounds in Table 8-1 with the exception of benzo(j)fluoranthene. An analytical standard is not available for this compound. The calibrated response of the closest eluting isomer, benzo(k)fluoranthene, will be used to establish a response factor. The quantitation ion, confirmation ion and percent abundance values for benzo(k)fluoranthene will also be used.

8.2 Non-Criteria Analyses

All non-criteria analyses will follow the calibration requirements described in the Contract Laboratory Program Statement of Work for semivolatiles (CLP SOW) dated 7/87. In summary, the SOW requires an initial verification that the mass spectrometer is tuned properly using decafluorotriphenyl phosphine (DFTPP). The SOW also requires an initial five-point calibration be performed for all compounds and that this calibration be verified by the analysis of a daily calibration standard.

Calibration will be performed as specified in the SOW with the following exceptions:

1. The compounds used to calibrate the instrument are shown in Table 8-1.

2. The SPCC and CCC requirements in the CLP will not be used. The verification of the daily response requires that the response factor for any compound be within 35% of the response factor from the initial calibration.

8.3 Extended Analyses

In addition to the compounds listed in Table 8-1, the compounds shown in Table 8-2 are required to be determined in the extended monitoring program. This extended list of compounds include phenols and other PAHs specified for this project.

Analyses for the extended list of compounds will be performed on the semivolatiles extract prepared as described in the CLP SOW.

The compounds are measured simultaneously with the semivolatile compounds in the CLP SOW. However, a separate calibration standard is required for these compounds. Prior to calibrating the instrument with these compounds, the system is tuned with DFTPP and calibrated with the semivolatile compounds as specified in the CLP SOW. The compounds used to assess system performance and to verify the continuing calibration (SPCCs and CCCs) are used to verify that the system is in control.

TABLE 8-2
TARGET COMPOUNDS FOR EXTENDED ANALYSES

A. Other Carcinogenic PAH

benzo(c)phenanthrene
dibenz(a,c)anthracene
dibenzo(a,e)pyrene
dibenzo(a,h)pyrene
dibenzo(a,i)pyrene
7,12-dimethylbenz(a)anthracene
3-methylcholanthrene

B. Phenolics

phenol
2-Chlorophenol
2-methylphenol
4-methylphenol
2-nitrophenol
2,4-dimethylphenol
2,4-dichlorophenol
4-chloro-3-methylphenol
2,4,6-trichlorophenol
2,4,5-trichlorophenol
2,4-dinitrophenol
2-nitrophenol
4,6-dinitro-2-methylphenol
pentachlorophenol

8.4 Phenolics

A three-point calibration curve covering the linear range of the method will be analyzed prior to the analysis of any samples and with a minimal frequency of once per 12 hours.

9. ANALYTICAL PROCEDURES

9.1 Low Level Analysis of PAH and Heterocycles

A method has been developed for the analysis of selected target PAH and heterocycle compounds at the part per trillion level (ppt, ng/L) in water. The analysis is carried out by isolation of the target analytes by liquid-liquid extraction of the water sample with an organic solvent. Quantitation of the isolated target analytes is performed by gas chromatography/mass spectrometry (GC/MS) in the selected ion monitoring mode (SIM). The method is generally applicable for the measurement of any PAH or related compound. For this project, only those compounds listed in Table 8-1 will be determined.

In summary, a measured volume of sample is extracted with methylene chloride. Analysis of the concentrated extract is performed by gas chromatography/mass spectrometry using the selected ion monitoring scanning mode under electron impact ionization conditions. Specific details of this methodology can be found in Appendix B, Determination of Low Level (Part Per Trillion) PAH and Heterocycles in Water. This method is designed to analyze samples containing up to 600 ppt of an individual PAH. With dilution of the sample extract, the effective range of the method can be extended into the ppb range. However, sample dilutions may result in loss of information concerning recovery of surrogates. For this reason, an optional sample preparation technique is contained in the method. This optional technique can be used if historical information indicates that the target compounds are present in concentrations in excess of 600 ppt.

9.2 Non-Criteria Analyses

The selected target PAH and heterocycle compounds listed in Table 8-1 can be determined by GC/MS in the scanning mode at the ppb and higher concentrations. This analysis, termed non-criteria analyses, uses the methodology contained in the Contract Laboratory Program Statement of Work for semivolatiles dated 7/87 (CLP SOW). The only deviations from this SOW are as follows:

1. The calibration is performed as set forth in Section 8 of the QAPP.
2. The internal QC checks are set forth in Section 11 of this QAPP.
3. Data are reported only for those compounds listed in Table 8-1.

9.3 GC/MS Method For the Extended Monitoring Program

9.3.1 Scope and Application

This method covers the determination of the semivolatile compounds listed in Table 8-2 and includes the detection, identification and quantitation of other compounds with significant peak heights as specified in Section 4.3.4 of the RAP.

This method is restricted to use by or under the supervision of analysts experienced in the use of a gas chromatograph/mass spectrometer and in the interpretation of mass spectra. Each analyst must demonstrate the ability to generate acceptable results with this method.

9.3.2 Summary of Method

A measured volume of sample is extracted with methylene chloride. The methylene chloride extract is dried, concentrated to a volume of 1 mL and analyzed by GC/MS. Qualitative identification of the parameters in the extract is performed using the retention time and the relative abundance of three characteristic masses (m/z). Quantitative analysis is performed using the internal standard techniques with a single characteristic m/z.

The procedure is performed as specified in the July, 1987 CLP Statement of Work for semivolatile organic compounds.

The only deviations from the CLP SOW are as follows:

1. Analysis of a separate calibration standard containing the compounds of interest as described in Section 8 of the QAPP.

2. Acquisition and reporting of data for the additional compounds listed in Table 8-2.

9.4 Phenolics

Phenolics will be determined by Method 420.2 as published in the "Methods for Chemical Analysis for Water and Waste, EPA 600/4-79-020" (refer to Appendix B). Not for

Not in App. B

10. DATA REDUCTION, VALIDATION AND REPORTING

10.1 Data Reduction and Validation

All project data will be subjected to a three-tier process including review by operations, by the data review groups for inorganics and GC/MS and the final review by the project coordinator prior to its release. The review process has been developed to minimize errors associated with sample processing, sample analysis and data reporting and to ensure that information pertaining to a given sample is well documented.

Appendix A contains Standard Operating Procedures (SOP's) for laboratory data review. Refer to SOP No. LP-RMA-0002 for information relative to review policies and processes.

10.2 Turnaround Time

In accordance with Section 3.2 of the RAP, RMAL has agreed to a 30 working day turnaround. The City, however, makes no enforceable commitment under the RAP except for a maximum of 7 days from sampling for extraction of organics and 40 days following extraction for analysis of organics. For non-organic analyses, the City makes no enforceable commitment under the RAP except to meet the recommended maximum analytical holding times.

10.3 Reporting/Data Deliverables

RMAL shall prepare summary reports and data packages in a format that mimics the format described in Exhibit B of Organic SOW 7/87 for the Contract Laboratory Program. Specifically, Form 1, SV-1 and SV-2 in Exhibit B of the CLP SOW will be changed to include the PAH list of parameters shown in Table 8-1 of the QAPP. Form II, SV-1 will show the surrogates for the PAH analysis. Form III, SV-1 will show the spike compounds for the PAH analyses. Form VI, SV-1 and SV-2 and Form VII, SV-1 and SV-2 will be altered to show just the target parameters shown in Table 8-1 of the QAPP. Finally, Form VIII, SV-1 and SV-2 will be modified to show the internal standards for the PAH method. In addition, in the low level PAH analyses, compounds which are determined to be present in the samples based on careful inspection of the data, but which do not meet the secondary ion confirmation criteria will be flagged with an asterisk (*). The reporting forms in Exhibit B will be modified to show the target lists of parameters, surrogates and spiking compounds for the low level PAH.

RMAL has determined the method detection limits for the part per trillion PAH analysis of water samples, utilizing GC/MS selected ion monitoring, according to the method described in Appendix B to Part 136 of the Friday, October 26, 1984 Federal Register, Vol. 49, No. 209 - Definition and Procedure for the Determination of the Method Detection - Revision 11.1. Table 10-1 lists the compounds, the observed concentrations of seven replicates spiked at 5 parts per trillion, the standard deviations and the method detection limits. RMAL has also determined the method detection limits for part per billion Phenolics according to Method 420.2 as published in the "Methods for Chemical Analysis for Water and Waste, EPA 600/4-79-020" (see Table 10-2).

Compound	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Standard Deviation (s)	Method Detection Limit (3s) *
2,3-Benzofuran	19.4*	20.9*	18.0*	19.5*	20.3*	21.5*	16.6*	1.70*	5.1*
2,3-Dihydroindene	4.3	4.2	4.7	3.7	3.8	4.9	4.7	0.46	1.4
1H-Indene	4.4	4.2	4.6	3.9	4.1	4.7	4.6	0.30	0.9
Naphthalene	20.5*	21.0*	18.5*	20.3*	23.0*	23.5*	17.6*	2.15*	6.5*
Benzo(B)thiophene	3.6	3.5	3.9	3.4	3.3	3.8	4.1	0.29	0.9
Quinoline	4.7	4.0	4.1	3.7	3.3	4.4	4.1	0.45	1.4
1H-Indole	3.7	4.5	5.6	3.2	3.2	4.2	4.0	0.84	2.5
2-Methylnaphthalene	5.4	5.0	5.3	5.1	4.8	4.9	5.7	0.31	0.9
1-Methylnaphthalene	4.5	4.2	4.6	3.8	3.7	4.7	5.2	0.53	1.6
Biphenyl	17.9*	18.1*	16.4*	18.4*	18.1*	19.3*	15.0*	1.43*	4.3*
Acenaphthylene	3.9	3.6	4.6	3.7	3.5	4.4	4.5	0.46	1.4
Acenaphthene	4.2	3.7	4.7	3.5	3.5	4.1	4.1	0.43	1.3
Dibenzofuran	4.3	3.9	4.6	4.1	3.7	4.6	4.2	0.34	1.0
Fluorene	4.4	4.0	4.5	4.0	4.0	4.6	4.8	0.33	1.0
Dibenzothiophene	4.0	3.5	4.0	3.5	3.2	3.9	4.2	0.36	1.1
Phenanthrene	4.7	3.9	4.7	3.9	3.6	4.2	4.5	0.43	1.3
Anthracene	4.5	3.8	4.5	4.1	3.6	4.1	4.6	0.38	1.1
Acridine	4.1	4.3	4.9	4.1	3.8	2.4	2.3	0.98	2.9
Carbazole	4.5	3.2	4.8	3.5	3.9	3.1	3.8	0.64	1.9
Fluoranthene	4.5	3.8	4.7	3.9	3.6	4.4	4.7	0.45	1.4
Pyrene	4.3	3.7	4.4	3.9	3.4	4.2	4.7	0.45	1.4
Benzo(A)anthracene	4.6	3.6	4.0	3.6	3.3	5.3	5.3	0.83	2.5
Chrysene	4.3	3.3	3.7	3.3	2.9	5.1	5.3	0.94	2.8
Benzo(B)fluoranthrene	4.6	3.4	3.8	3.6	2.8	4.9	5.0	0.83	2.5
Benzo(K)fluoranthrene	4.1	3.2	3.5	3.2	3.2	4.9	4.8	0.76	2.3
Benzo(E)pyrene	4.9	3.8	4.1	3.3	3.5	4.9	4.4	0.64	1.9
Benzo(A)pyrene	4.5	3.2	3.8	3.2	2.9	4.8	4.5	0.78	2.3
Perylene	4.6	3.6	3.8	3.5	3.3	5.3	5.1	0.82	2.5
Indeno(1,2,3-CD)pyrene	4.5	3.4	3.4	2.9	3.0	4.5	4.2	0.69	2.1
Dibenz(A,H)anthracene **	4.2	3.5	3.6	3.1	3.3	4.6	4.1	0.54	1.6
Benzo(G,H,I)perylene	3.8	3.0	2.9	2.6	2.9	4.9	4.7	0.94	2.8

Note: Amount spiked = 5 ng/L.

* Data for 2,3-Benzofuran, Naphthalene and Biphenyl were obtained from previous detection limit study. Spike levels = 20 ng/L.

** Compounds co-elute

Figure 10-1 Method Detection Limit Report

TABLE 10-2

METHOD DETECTION LIMIT STUDY - TOTAL PHENOLICS

Sample #	Concentration Detected (mg/L)
1	0.0315
2	0.0340
3	0.0291
4	0.0315
5	0.0291
6	0.0291
7	0.0315

Calculated Standard Deviation = 0.0018

Calculated Method Detection Limit = 0.00579 mg/L
= 5.8 ug/L

These calculated method detection limits will be used in sample reporting as follows:

- Analytes detected at concentrations greater than or equal to the calculated method detection limits will be reported with no qualifiers.
- Analytes that are detected at concentrations less than the calculated method detection limits will be reported followed by a "J" qualifier which is used in the EPA Contract Lab Program (CLP) to indicate that a reported value is below the method detection limit.

The various items in the data package are listed below:

- Sample Traffic Reports or Chain-of-Custody
- Sample Data Summary Report Including:
  - Case narrative
  - Tabulated target compound results by fraction
  - Surrogate spike analysis results by fraction
  - Matrix spike/matrix spike duplicate results by fraction
  - Blank data by fraction
- Sample Data Package including:
  - Case narrative
  - Traffic reports
  - Raw data

The City will present reports in a manner consistent with the requirements of the RAP. In addition, data packages containing all elements listed above will be presented for up to 10 percent of the sample analyses completed. The EPA shall be responsible for identifying the specific sample analyses for which data packages will be provided.

10.4 Reporting Requirements for Samples Exceeding Advisory Levels or Drinking Water Criterion

For active drinking water wells, RMAL will notify the City of St. Louis Park by telephone, within 24 hours of completing an analysis, whenever a sample analysis is shown to exceed the following Advisory Levels or Drinking Water Criterion:

Parameter	Advisory Level	Drinking Water Criterion
Sum of Benzo(a)pyrene and Dibenz(a,h)anthracene*	3.0 ng/L*	5.6 ng/L
Total Carcinogenic PAH +	15 ng/L**	28 ng/L*
Total Other PAH	175 ng/L	280 ng/L

*Or the detection limit, whichever is largest.
**Different concentrations for additional carcinogenic PAH may be established in accordance with the procedure specified in Part D.1 of the Consent Decree.

+See Table 10-3.

TABLE 10-3

CARCINOGENIC PAH

benz(a)anthracene
benzo(b)fluoranthene
benzo(j)fluoranthene
benzo(ghi)perylene
benzo(a)pyrene
chrysene
dibenz(a,h)anthracene
indeno(1,2,3-c,d)pyrene
quinoline

10.5 Final Evidence Files

The final evidence (or data) files will be maintained by RMAL for the period specified in the RAP. Evidence files will consist of all data necessary to completely reconstruct the analysis, and will consist of, (at a minimum): raw data, calibrations, QC, detection limits, result forms and the analytical report. RMAL will maintain these files in a secure, limited access area under the custody of the Director of Quality Control.

11. INTERNAL QUALITY CONTROL

The internal quality control checks will include field blanks, method blanks, surrogate spikes, duplicate analyses, monitoring of internal standard area and matrix spike analyses. Each quality control check has a specific level of performance which will be reevaluated in an ongoing basis and amended as appropriate through mutual agreement of the Agencies and City. The specific details are presented below.

11.1 Low Level PAH and Non-Criteria Analyses

Internal quality control checks for the low level and non-criteria PAH analyses will consist of method blanks, surrogate compound analysis, matrix spike analysis, analysis of duplicate samples, and monitoring of internal standard areas.

11.1.1 Method Blank Analysis

A method blank consists of deionized, distilled laboratory water carried through the entire analytical scheme (extraction, concentration, and analysis). The method blank volume must be approximately equal to the sample volumes being processed.

Method blank analysis are performed at the rate of one per case*, each 14 calendar day period during which samples in a case are received, with every 20 samples of similar concentration and/or sample matrix, or whenever samples are extracted by the same procedure, whichever is most frequent.

An acceptable method blank analysis must not contain any carcinogenic PAH in Table 8-1 at concentrations greater than or equal to the Method Detection Limits (MDL) or any other PAH at a concentration greater than 5 times the MDL. If the method blank does not meet these criteria, the analytical system is out of control and the source of the contamination must be investigated and corrective measures taken and documented before further sample analysis proceeds.

* A case is a group or a set of samples collected from a particular site over a given period of time.

11.1.2 Surrogate Compound Analysis

As detailed in the SOP (Appendix B), the laboratory will spike all samples and quality control samples with deuterated PAH surrogate compounds. The surrogate compound will be spiked into the sample prior to extraction to measure individual sample matrix effects associated with sample preparation and analysis.

RMAL will take corrective action whenever the surrogate recovery is outside the acceptance criteria shown below. The corrective action is described in Section 15 of this QAPP.

Surrogate	Acceptance Criteria % Low-level	Non-criteria
Naphthalene-d8	14-108	25-175
Fluorene-d10	41-162	25-175
Chrysene-d12	10-118	25-175

11.1.3 Matrix Spikes

The laboratory will spike and analyze 5% matrix spike samples. RMAL will spike seven representative compounds into water. These compounds and the spiking levels are listed below:

	PPT	Non-Criteria
Naphthalene	20 ng/L	50 ug/L
Fluorene	20	50
Chrysene	20	50
Indene	20	50
Quinoline	20	50
Benzo(e)pyrene	20	50
2-methyl naphthalene	20	50

The matrix spike criteria for data validity are as follows:

- The average of the percent recoveries for all compounds must fall between 20 and 150 percent.
- Only one compound can be below its required minimum percent recovery. These minimum percent recoveries are:
  1) 10% for chrysene
  2) 20% for all other compounds.

Corrective action will be performed if these criteria are not achieved as described in Section 15.

11.1.4 Duplicates

Percent difference between duplicates will be calculated for each detected compound.

11.1.5 Internal Standard Areas

The area of the internal standard will be monitored on each analysis. The area from the daily calibration standard will be used to set a daily acceptance criteria. If the internal standard areas in samples changes by more than a factor of two (-50% to + 100%) from the daily standard, corrective action must be performed.

11.2 Extended Analyses

The internal quality control checks for extended analyses will consist of surrogate spikes, matrix spikes, method blanks, etc. as described in the CLP SOW for semivolatile organics. The acceptance criteria are as defined in the SOW.

11.3 Phenolics

The internal quality control checks for phenolics will mimic those for inorganics in the CLP program and will include the analysis of a method blank, a laboratory check standard, a spike sample, and a duplicate sample.

12. PERFORMANCE AND SYSTEM AUDITS

Enseco/RMAL will be subjected to USEPA Performance and System Audits for approval/disapproval specific to the requirements of this program. The Contract Project Management Section (CPMS) of the Central Regional Laboratory (CRL) of Region V is responsible for the audits.

Enseco laboratories participate in a variety of federal and state certification programs, (including the EPA CLP), that subject each of the laboratories to stringent system and performance audits on a regular basis. A system audit is a review of laboratory operations conducted to verify that the laboratory has the necessary facilities, equipment, staff and procedures in place to generate acceptable data. A performance audit verifies the ability of the laboratory to correctly identify and quantitate compounds in blind check samples submitted by the auditing agency. The purpose of these audits is to identify those laboratories that are capable of generating scientifically sound data. Enseco is certified to perform environmental analyses under programs administered by the EPA, U.S. Army, U.S. Navy, and over 15 states. The most current list of Enseco certifications is available upon request.

In addition to external audits conducted by certifying agencies or clients, Enseco regularly conducts the following internal audits:

- Monthly systems audits conducted by the Division Quality Assurance (QA) Director.
- Quarterly audits conducted by the Corporate VP of QA.
- Special audits by the Divisional QA Director or Corporate VP of QA when a problem is suspected.

Enseco laboratories also routinely analyze internal check samples as described below:

- Laboratory QC check samples (LCS, SCS, and blanks) are analyzed at a frequency equal to at least 10% of the total number of samples analyzed (see Section 9).
- An independent commercial firm is contracted to provide all laboratories with blind check samples on a monthly basis. The results of the analyses of these samples are evaluated by the VP of QA.

The results of these internal check samples are used to identify areas where additional training is needed or clarification of procedures is required.

13. PREVENTIVE MAINTENANCE

Since instrumental methods of analysis require properly maintained and calibrated equipment, the operation and maintenance of modern analytical instrumentation is of primary importance in the production of acceptable data. In order to provide this data, RMAL subscribes to the following programs:

- maintenance agreements/service contracts with instrument manufacturers
- laboratory preventive maintenance program

13.1 Service Contracts

Analytical equipment utilized by RMAL laboratory personnel for this project are covered by maintenance agreements with the instrument manufacturers. These manufacturers provide for both periodic "preventive" service calls as well as the non-routine or emergency calls.

13.2 Instrument Logbooks

Individual instrument logbooks are maintained for each piece of equipment and located near the instrument. General information contained in the logbooks include:

- Inventory information:
  equipment name, model number, serial number, manufacturer, date of acquisition, original cost
- Service tasks and intervals:
  cleaning, calibration, operation based on the manufacturer's recommended schedule, and previous laboratory experience
- Service record:
  date of breakdown, date of return to service, downtime, problems, repairs, cost of repairs, who performed the repairs, parts required, etc.
- calibration/performance checks
- daily operational notes

Analysts are referred to manufacturers' operating manuals for specific procedures to be followed in the operation and/or maintenance of the individual instruments.

Laboratory preventive maintenance includes any tasks that can be performed in-house, i.e., systematic cleaning of component parts as recommended in the instrument manual. If problems cannot be corrected by laboratory personnel, the instrument service representative is contacted and a service call requested to correct the problem.

14. SPECIFIC PROCEDURES TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

A quality control program is a systematic process that controls the validity of analytical results by measuring the accuracy and precision of each method and matrix, developing expected control limits, using these limits to detect errors or out-of-control events, and requiring corrective action techniques to correct, prevent or minimize the recurrence of these events. The quality assessment techniques described below consist of the techniques used to assure that statistical control has been achieved.

The accuracy and precision of sample measurements are influenced by both external and internal factors. External factors or errors are those associated with field collection and sample transportation. Internal factors or errors are those associated with laboratory analysis. External factors are defined briefly in Section 14.1. Internal factors are defined in Section 14.2.

14.1 External Components

The results for quality control samples taken in the field represent the best estimates of accuracy and precision for the samples, since these values reflect the entire process from samples collection through sample analysis. The frequency of these control samples is described in Sections 5 and 6. Below is a brief description of the information provided by each of these control samples:

- Field blank - provides an estimate of bias based on contamination; includes effects associated with sample preservation, shipping, preparation, and analysis.

- Field collected samples or duplicates - independent samples collected at the same point in space and time. These give the best measurement of precision for sample collection through analysis.

14.2 Internal Components

The results of quality control samples created in the laboratory represent estimates of analysis and precision for the preparation and analysis steps of sample handling. This section describes the quality control-type information provided by each of these analytical measurements. The frequency of each of these measurements is discussed in Sections 5 and/or 11.

- Surrogates - provide an estimate of bias based on recovery of similar compounds, but not the compounds analyzed, for each sample, preparation and analysis.

- Internal standard - an analyte that has the same characteristics as the surrogate, but is added to the sample extract just prior to analysis. It measures bias or change in instrument performance from sample to sample, incorporating matrix effects associated with the analysis process only.

- Matrix spikes - the matrix spike is added prior to preparation and analysis. The analyte used is the same as that being analyzed and usually is added to a selected few samples in a batch of analyses. It incorporates matrix effects associated with the laboratory analysis.

- Method blanks - provide an estimate of bias based on contamination.

14.3 Calculation Techniques

The quality assessment procedures described above require calculations of relative percent difference (duplicate analyses) and percent recovery (matrix and surrogate spikes). The techniques for performing these calculations are described below.

- Precision - is the degree to which the measurement is reproducible. Precision is assessed by duplicate measurements by calculating the Relative Percent Difference (RPD) between duplicate measurements. The RPD is calculated as follows:

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \times 100$$

where: RPD = relative percent difference

D_1 = first sample value

D_2 = second sample value (duplicate)

- Accuracy - is a determination of how close the measurement is to the true value.

  The determination of the accuracy of a measurement requires a knowledge of the true or accepted value for the signal being measured. Accuracy may be calculated in terms of percent recovery as follows:

$$\text{Percent Recovery} = \frac{X}{T} \times 100$$

where:

X = the observed value of measurement

T = "true" value

- Completeness - is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions.

To be considered complete, the data set must contain all QC check analyses verifying precision and accuracy for the analytical protocol. In addition, all data are reviewed in terms of stated goals in order to determine if the data base is sufficient.

When possible, the percent completeness for each set of samples is calculated as follows:

$$\text{Completeness} = \frac{\text{valid data obtained}}{\text{total data planned}} \times 100\%$$

- Comparability - expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, etc.), and consistency in reporting units (ppm, ppb, etc.).

15. CORRECTIVE ACTION

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is somewhat dependent on the analysis and the event.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks contain target analytes above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA department.

Generally, out-of-control events or potential out-of-control events are noted on an out-of-control event form (see Figure 15-1). This form is part of the data package and, thus, must be completed prior to data approval. If an out-of-control event does occur during analysis, for instance, a surrogate recovery falls out the expected range, the analyst must describe on this form: the event, the investigative and corrective action taken, and the cause of the event, and notify the Laboratory Quality Control Director. In some cases, investigation of an out-of-control event will reveal no problems. In such cases, only the event and the investigative action is recorded. If an out-of-control event is discovered during data package review, the Laboratory Quality Control Director notifies the supervisor for corrective action.

15.1 Low-Level PAH and Extended Analyses

15.1.1 Surrogates

As discussed in Section 11.1.2, corrective action will be performed whenever the surrogate recovery is outside the following acceptance criteria:

QC Lot _____

Associated Samples _____

PROBLEM: (Briefly decribe problem) _____

Analyst:
Date:

- -

RESULTS/CONCLUSIONS of the Investigation:

Analyst:
Supervisor:
Date:

- -

CORRECTIVE ACTIONS (including follow-up)

Supervisor:
QA Approval:
Date:

Figure 15-1 Warning/Out-of-Control Form

Surrogate	Acceptance Criteria % Low-Level	Non-criteria
Naphthalene-d8	14-108	25-175
Fluorene-d10	41-162	25-175
Chrysene-d12	10-118	25-175

The following corrective action will be taken when required as stated above:

a) Check calculations to assure there are no errors;

b) Check internal standard and surrogate solutions for degradation, contamination, etc., and check instrument performance;

c) If the upper control limit is exceeded for only one surrogate, and the instrument calibration, surrogate standard concentration, etc. are in control, it can be concluded that an interference specific to the surrogate was present that resulted in the high recovery and this interference would not affect the quantitation of other target compounds. (The presence of this type of interference can be confirmed by evaluating the chromatographic peak shapes and ion intensities of the surrogates.)

d) If the surrogate could not be measured because the sample required a dilution, no corrective action is required. The recovery of the surrogate is recorded as D with the note surrogate diluted out.

e) Reanalyze the sample or extract if the steps above fail to reveal a problem. If reanalysis of the extracts yields surrogate spike recoveries within the stated limits, then the reanalysis data will be used. Both the original and reanalysis data will be reported.

15.1.2 Matrix Spikes

The matrix spike criteria for data validity are as follows:

- The average of the percent recoveries for all compounds must fall between 20 and 150 percent.

- Only one compound can be below its required minimum percent recovery (10%).

If the matrix spike criteria are not met, the matrix spike analysis will be repeated. If the subsequent matrix spike analysis meets the criteria, the data will be considered valid. Both matrix spike and surrogate spike recoveries will be used in assessing quality assurance/quality control for RMAL's analytical work.

15.1.3 Blanks

If target compounds are detected in the method blank above the MDL but less than 5 times the MDL the corrective action will consist of flagging the data and investigating the source of the problem to implement a corrective action for future work. If the concentration of a compound in the method blank exceeds five times the MDL, additional corrective action, including but not limited to, reanalysis of the blank and reanalysis of the samples may be required.

The relative concentration of compounds in both the samples and the blank are assessed as part of this corrective action. The results of these activities are documented in the narrative.

15.2 Other Corrective Actions

These sections discuss corrective actions which will be taken in the event that a sample or sample extract is lost or destroyed during shipment, storage or analysis, or in performance and system audits.

15.2.1 Samples

In order to minimize the possibility of sample destruction during shipment, six 1-liter bottles will be taken for all low-level (ppt) samples. For all samples, field blanks, matrix spikes, and matrix spike duplicates, subsequent extraction and analysis will be conducted on four intact 1-liter bottles. All field blanks will be collected in duplicate. One field blank will be analyzed with the sample set and the duplicate will be extracted and held. In the event that the field blank is lost during analysis or invalidated, the duplicate field blank will be analyzed and reported. Additional sample matrix will be required for matrix spike/matrix spike duplicate analyses.

If less than four liters of a sample remains after shipment and storage for analysis, the Program Manager will be notified and another sample will be collected and shipped to the laboratory for analysis. The analysis report for the sample batch containing the affected sample will clearly note in the discussion section that a replacement sample was taken.

15.2.2 Sample Extracts

If a sample extract is broken or lost during analysis, the Program Manager will be notified and will be responsible for determining the need for replacing the lost sample. The analysis report for the sample batch containing the affected sample will clearly note in the discussion section the action taken.

15.2.3 Quality Control Samples

If a method blank, or matrix spike is lost or broken during analysis, a replacement QC sample will be sampled and analyzed. The analysis report will clearly note that a replacement QC sample was analyzed.

If a field blank is lost or broken during shipment, storage, or analysis, its duplicate will be analyzed. The analysis report for the sample batch associated with the field blank will clearly note the occurrence in the discussion section.

15.2.4 Performance and System Audits

Each system audit is immediately followed by a debriefing, in which the auditor discusses his findings with the laboratory representatives. The debriefing serves a two-fold purpose. First, laboratory management is afforded an early summary of findings, which allows them to begin formulating corrective strategies, and second, the auditor has a chance to test preliminary conclusions and to correct any misconceptions before drafting his report.

The systems audit report (which may or may not contain performance audit findings) is first issued in draft to the Laboratory Quality Control Director. The QC Director distributes the draft to the Laboratory Director and appropriate supervisors to solicit comments and/or rebuttals. These responses are forwarded, in writing, to the auditor. The auditor makes revisions to the draft, on the basis of these responses, at his discretion. Any points of disagreement between the QA department and the laboratory organization are resolved through discussion before the final report is issued. Written responses to the draft report are attached to the final report as an appendix.

Final audit reports are issued to project management and to corporate management. Items requiring corrective action are documented on a Corrective Action Request Form addressed to the project manager. One copy is retained by QA upon issuance. The project manager receives the original and one copy. When satisfactory progress has been achieved on each requested action, the project manager or designee enters descriptions of actions and results on the form, then retains the copy and returns the original to QA to close the loop.

16. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Executing and administering an effective QA program in a large and complex laboratory system demands the skills of a highly qualified staff. The organizational structure of Enseco's Quality Assurance Group (Fig. 16-1) provides a disciplined national management network which oversees and regulates all laboratory QA functions.

Enseco's Quality Assurance Group is headed by Kathleen A. Carlberg, Corporate Vice President of Quality Assurance, who reports directly to the Enseco Executive Committee and to the Chairman of the Board. As principal architect of Enseco's QA program, Ms. Carlberg has charted a rigid course to monitor and control laboratory operations. This involves the intricate process of developing QA manuals, QC protocols, training programs, Standard Operating Procedures (SOP's), uniform statistical data, interlaboratory and intralaboratory performance evaluation studies, and internal auditing programs. Ms. Carlberg is responsible for the administration and implementation of the QA program at all Enseco laboratories.

Laboratory QA activities are specifically designed to fulfill the requirements of both the individual laboratory and Enseco. Directing these activities as Division Director, Mark J. Bollinger, Ph.D. works closely with the laboratory Quality Assurance Director, Gary Torf, who enforces and monitors the program.

Because a QA program undergoes its most stringent test at the laboratory level, Laboratory QA Officers hold a cornerstone position in the organizational structure. Enseco QA Officers are highly skilled analytical scientists, knowledgeable in all aspects of laboratory operations. Their responsibilities include diagnosing quality defects and resolving problems with the analytical system; conducting performance evaluation studies, in-house audits, and walk-throughs; performing statistical analyses of data; auditing spike sample results; enforcing chain-of-custody procedures; assisting in the development of QA manual, SOPs and QC protocols; conducting QA training programs; and maintaining extensive records and archives of all QA/QC data.

Laboratory QA Officers report to both the laboratory president and to Ms. Carlberg. They also interface with one another in a peer evaluation and auditing system that encourages assistance and feedback, problem analysis, and collaboration on ways to improve laboratory performance.

In conjunction with the Laboratory QA Department, laboratory vice presidents, directors, and managers are responsible for a subset of QA activities, and work closely with supervisors to evaluate daily laboratory functions.

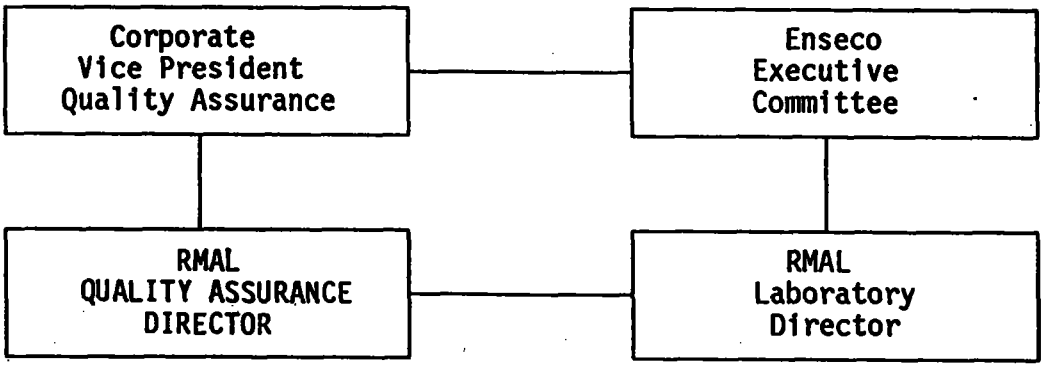


FIGURE 16-1 ENSECO QUALITY ASSURANCE GROUP ORGANIZATION CHART

The reporting system is a valuable tool for measuring the overall effectiveness of the QA program. It serves as an instrument for evaluating the program design, identifying problems and trends, and planning for future needs. Divisional QA Directors submit extensive monthly reports to the VP of QA and the Divisional Director. These reports include:

- The results of the monthly systems audit including any corrective actions taken;
- Performance evaluation scores and commentaries;
- Results of site visits and audits by regulatory agencies and clients;
- Performance on major contracts, (including CLP);
- Problems encountered and corrective actions taken;
- Holding time violations; and
- Comments and recommendations.

In addition, on a weekly basis, a summary of the 5% QA audit of reported data is sent to the Corporate QA Office.

The VP of QA submits weekly reports to the CEO and monthly report to the Enseco Management Committee and each Divisional Director. These reports summarize the information gathered through the laboratory reporting system and contain a thorough review and evaluation of laboratory operations throughout Enseco.